t part man

Proliminary report on the engineering goology of the Ridersde Springs quadrangle, Bon and Jefferson Counties, Calerade OPEN FILE - 1969 Bheet b of 5 sheets DEPARTMENT OF THE INTERIOR UNITED STATES Generalized description of engineering geologic aspects of solimentary bedreak in the Eldorede Springs quadrangle, Calorede Suitability for Poundation stability Slope stability Probable Worksbility Surface drainage Topographic form Weathering and Description, thickness, and structure quivalent geologic earthquake stability Engineering waste disposal unit (s) geology unit name erosion surface relief map symbol and where cuts are less than 20 ft high. For faces cut perpendicular to strike of bedding, or where fery poor to fair, depending on load, foundation design, and change in molisture content after Infiltration:
negligible.
Punoff: rapid; water
may accumulate in
local shallow ently rolling alluvium- and here buried by surficial deposits, Permeability: negligible in Septic systems: generally unsatisfactory; Excavation: easy to depth of 15 ft with Highly swelling claystone and Claystone, silty, and siltstone, very clayey erre Shale (part): material for manufacture of good. Locally to sandy: firmly cemented, dense and hard; overconsolidated; laminated, shaly; bedding (Baculites grandis) and B. clinolobatus zon including basal part of upper colluvium-covered plains; slopes as steep as 150 along flanks of mesas east of uppermost zone of unitypically composed of two subzones: upper, generally 1-3 ft, altered to unweathered and in decomposed subzone; very low to negligible most power equipment including tractoroverconsolidated; laminated, shaly; bedding even, persistent laterally; light gray where unweathered; composed chiefly of clay minerals (calcium montmorillonite and mixed-layer illite-montmorillonite are about equally abundant) and quarts, plus minor amounts of feldsper, calcite, and dolonite; PVC2/ rating, 3.4-7.4 marginal to very critical; swell index, 2,800-5,900 psf. About 1,000 ft thick. Contains sparse 1/h. to 2.in .thick beds of bentonite poor at to of high cuts or or steep hillsides. expanded shale for lightweight drawn scrapers and backhoes. generally too siltaton construction. L@cally expands excessively, in subsone jointed by desiccation. bedding dips away from cut, slopes cut at 1 horizontal to 1 vertical probably aggregate. Source of poor depressions for as long as a week.

Susceptibility to
erosion: moderate by
gully wash; high by
sheet wash; moderate
by wind deflation
where longered. CE-29 Compaction: easy; sheepsfoot reliers ecomonly used. Drilling: moderately excellent because excevation easy transition member rield to wells: negligible; locally and exerts high swelling pressures moisture content countain front to very poorsafe. Locally poor to hazardous for vertical or steep cuts higher than 20 ft. Stability investigaquality stiff clay and silt impervious fill and binder yields very small quantities. Ground water commonly seeps along base of overand rick slight of ground-water pollution. (CH, CL, MH, ML3/) increases. Bentonite beds unsuitable: and lover subzone, generally 3-6 ft thick, composed of hard yellowish-gray-stained claystone and material; poor chiefly because About 1,000 ft thick. Contains sparse
1/h- to 2-in.-thick beds of bentonite
composed mostly of calcium montmoriflonite;
PVC2/ rating greater than 10, very critical;
swell index greater than 14,000 psf. Also
sparse hard, brittle calcareous concretions
as much as 18 in. longest dimension.
Dip of beds: 250-65° E. tions recommended, particularly where bedding chiefly been high swell potential. expend exorbitantly, where loosened by exert very high swell pressures, and have low shearing strength. Susceptibility to frost heave high. ploving or construction. Difficult to reestablish lying surficial deposits, through sparse sandy beds, along fractured somes particularly where bedding surfaces, bentonite beds, or clay seems dip toward proposed excavation at any angle lower than that angle to which sleps will be out. State regulations require support or 45° repose in exceptions. siltstone jointed chiefly by desiccation in fresh rock, and along bedding plane vegetation. into small angular blocks. Where not covered by surficial atop bentonite beds Quality: hard; sulfate deposits, upper iron contents very high, locally oily. subzone commonly removed by erosion; Dee: generally not practical. much as 15 ft thick; highly susceptible to claystone and shale, silty, and minor siltstone, clayey to sandy: firmly cemented
dense and hard; overconsolidated;
laminated to fissile; bedding even,
persistent laterally; gray to black where
unweathered; composed chiefly of clay
minerals (mixed-layer illite-montmorillonite
slightly more abundant than illite), and
quartz, plus minor calcits, feldspar, and
in some beds gypsum and pyrite; PVC2/ rating
1.3-5.1 noncritical to critical; swell imdex,
1,150-4,000 psf. Map unit includes four
belts paralleling mountain front and
separated by map units of different lithologies. Eastern belt about 1,800 ft/thick,
east-central belt about 500 ft thick, westcentral belt about 200 ft thick, westcentral belt about 200 ft thick, westcentral belt about 200 ft thick, vestcentral belt about 211te-montmorillonite
with some bentonite beds in west-central zone
composed chiefly of kaolinite; PVC2/ rating
1.3-7.7, noncritical to very critical; swell
index, 1,100-6,200 psf. Also sparse hard,
brittle calcareous concretions as much as 16
in. in longset dimension. Infiltration: Permeability: Same as for above. oor to fair depending upon load, foundation design, and change in 0 00 fte me as for above for above. derre Shale (part): Claystone and shale, silty, and minor silt-Moderately quality impervious fill and binder svelling elaystone and Shale lower transition member through surficial deposits, for above. Compaction: Drilling: Se uppermost zone of unit typically off: Same Yield to wells: Same. my sites: Seme. beneer through lover part of Baculites obtusus 2 tone, B. Jenseni, B. eliasi, and B. baculus zones; upper part of Didymogras usceptibility to Quality: composed of two sub-zones: upper, generally 2-6 ft thick, altered to construction. ca-sh Generally expands moderately, and exerts moderate swelling light gray very stiff to hard clay (CL, CH, CL-NG.3/), and lower pressures when moist of Didymoceras Bentonite beds
unsuitable: expand
excessively, exert
high swell pressures,
and have low shearing nebrascense, D. stevensoni, Exiteloceras jenneyi, and D. subzone, generally 2-8 ft thick, composed of hard claystone and shale jointed chiefly strength. Succeptibility to freet heave high. by desiccation into small conchoidal fragments. Where not covered by surficial deposits, upper sub-sone commonly removed by erosion; lower sub one as much as 15 ft thick; highly susceptible to slaking. in. in longest dimension. Dip of beds: 400-800 E. Pierre Shale (part):
from top of Hygiens
Sandstone Member
through lower part
of Didymoceras
nebrascense,
Baculites
Siltstone and shale, clayey to sandy, and minor
claystone and sandstone: well cemented, very
dense and vsry hard; overconsolidated; thinly
laminated to fissile; bedding even, persistent laterally; gray to olive gray where
unweathered; composed chiefly of quartz,
calcite, and clay minerals (mixed-layer

calcite, and clay minerals (mixed-layer

from top of Hygiens
claystone and shale, clayey to sandy, and minor
claystone and sandstone: well cemented, very
alluvium-cov
plains; slope
steps as 250
flanks of mes Excavation: mostly easy to depth of 10 ft with Slightly here buried by Infiltration: Permeability: Sess as nerally fair. Expands e es fer eptic systems: for above. Yield to wells: Quality: Same. Use: Same. svelling siltstoom alluvium- and colluvium-covere surficial deposits, uppermost some of generally unsatisfactory; slightly and exerts generally low swelling Runoff: Same. Susceptibility to power equipment including tractorplains; slopes as steep as 25° along flanks of mesas east of mountain unit typically composed of two subzones: upper, generally 1-2 ft percolation generally too pressures when moistu content increases. of Didymoceras nebrascense, Baculites drawn scrapers and backhoes. Moderately difficult locally in srosion. & Bentonite beds
unsuitable: most
expand excessively,
exert high swell generally good because risk calcite, and clay minerals (mixed-layer illite-montmorillonite slightly more abundant than illite), plus minor feldspar and, in some beds, gypsum; PVC2/ rating, 0.7-2.8, noncritical to marginal; swell index, 700-2,300 psf. Map unit includes four belts paralleling mountain front and separated by map units of different lithologies: eastern belt about 700 ft thick, east-central belt about 200 ft thick year-central belt about 500 ft thick 500 ft thick year-central belt about 500 ft thick yea thick, altered to olive-gray to darksome siltstone, concretion, and sparse compressus, B. cuneatus B.
reesidei zones.
iobrara Formatios concretion, and sparse sandstone beds. Compaction: moderately easy; sheepsfoot rollers commonly used. Drilling: moderately easy to moderately difficult. slight of ground-water pollution: locally fair gray clayey to sandy silt (ML, CL, CE2/), pressures, and have low shearing strength (part): Smoky Will Shale Member and lower subzone, generally 4-6 ft thick, Susceptibility to frost heave modera Greenhern Limesto Carlile Shale. jointed chiefly by desiccation into because siltate and concretions belt about 700 ft thick, east-central belt about 520 ft thick, west-central belt about 520 ft thick, western belt about 230 ft thick contains sparse 1/8- to 5-in.-thick beds of bentonite composed chiefly of mixed-layer illite-montmorillonite and lesser amounts of illite and kaolinite; PVC2/ rating, 0.6-7.3, noncritical to very critical; swell index, 600-5,800 psf. Also zones of numerous hard, buttle celemants conventions as much as small blocks and conchoidal fragments moderately difficult to of very hard siltstone and shale. Where not covered by surficial deposits, upper subsome commonly removed by erosion; lover sub zone as much as 10 ft thick; moderately to highly susceptible to slaking. brittle calcareous concretions as much as 2 ft longest dimension. Dip of beds: on east flank of hogbacks, 30° E., through vertical, to 55° W.; extensively faulted. In eastern belts of map unit, beds dip k0°-80° E. surficial deposits, uppermost zone of unit typically composed of two subzones: upper, Drilling: Same. for above. Claystone, silty, and siltstone, very clayey: firmly cemented, dense and hard; over-consolidated; thinly laminated; bedding even, there buried by surficial deposits, Same as for
"Swelling claystone and siltstone (cs-ms)." Pierre Shale (part): Mostly Gently rolling perally fair to good. so as for above. e as for May in places swell slightly and exert low nonsvellin alluvium- and colluvium-covere upper part
Baculites obtusus
sone to base of Runoff: Seme. Susceptibility to Tield to wells: consolidated; thinly laminated; bedding even, persistent laterally; gray where unweathered; composed chiefly of quartz, clay minerals (mixed-layer illite-montmortilonite slightly more abundant than illite, plus kaolinite and chlorite in minor amounts), plus minor feldspar and dolomite; PVC2/rating, 0.8-1.8, plains; slopes as steep as 150 along flanks of mesas east of mountain swelling pressures when moisture content Quality: Sam Eyglene Sandstone erceien: generally 1-3 ft thick, altered to increases. Beds of kaolimitic clay sites: olive-gray very stiff silty clay (CL, ML2/) noncritical; swall index, 800-1,500 pef.
About 1,500 ft thick. Contains very sparse
1/2- to 3-in.-thick beds of chiefly
kaolimitic white to light-gray clay; Pvc2/
rating, 2.6, marginal; swell index, 1,700
pef. Also scores of sparse, bard, brittle
calcareous concretions as much as 18 in.
leagest dimension.
Dip of beds: bc0-80° E. and lower subzone, generally 3-6 ft thick, jointed chiefly by desiccation into moderate swell pressures, and have low shearing strengths. High susceptibility to freet heave. by desiccation into small hard yellowish-gray-stained blocks of claystone and silt-stone. Where not covered by surficial deposits, upper subzone commonly removed by erosion; lower subzone as much as 15 ft thick; highly susceptible to slaking. fhere naturally exposed, surface of siltstone and sandstone commonle case-hardened; lime-Siltstone (%6 percent), sandstone (20 percent), claystone (30 percent) and limestone (% percent): moderately to well cemented. Bods lenticular, interlayered, and ef variable thickness and lateral extent; varicolored. Permeability: varies,
probably very low te
negligible.
Water table: generally Excavation: Soderately difficult with heavy Light structures:

generally fair to good;
locally may expand and
exert moderate swelling Morrison Formation; Ralston Creek negligible.
Runoff: medium to rapid. bods dip into hillside. claystone generally unsatisfactory; rippers and scrapers; blasting required ened and pitted by limesto percolation selution. Claystone locally; claystone easy with most power Susceptibility to
erosion: negligible
where protected by
surficial deposits, none.
Yield to wells: not known to yield water generally too slow. comsonly buried by surficial deposits, generally fractured and weakened to depth of 3-6 ft below base of surficial deposit. Claystone and siltclay minerals in the claystone chiefly mixed layer illite-montaorillonite and illite; in some beds kaolinite equally abundant; FVC2 rating characteristically noncritical. Some gypsum and anhydrite in lower part. About 383 ft thick.

Dip 87 beds: \$\frac{10.0}{2.0} = 60^9 \text{ E.} moisture change in sparse lense of swelling claystone or equipment.

Compaction: moderately

difficult; hauling
equipment, smooth-tire
rollers commonly used.

Drilling: moderately

difficult. chiefly because slope too steep and risk moderate to wells in area. anhydrite. Heavy structures: poor; may settle unevenly but high where claystone exposed. of pollution passing inte nearby aquifers because of local stone highly suscep-tible to slaking. Sandstone and limestrength, or loss of gypeum by leaching. steme resistant to Permeability: low to

very low.

Water table: generally

varies in depth;
conforms generally te
slope of surface;
vater moves mostly
along fractures
parallel to bedding.

Yield to wells: varies
widely; generally less
than 3 gpm. Encrusta-Siltstone, clayer to sandy; moderately to well cemented; thin-bedded, slabby to laminated, shaly; bedding even, persistent laterally; reddish brown; composed chiefly of ealcite, quartz, and mica with minor amounts of clay minerals (chiefly illite, some mixed-layer chlorite-montmorillonite), and hematite; PVC²/ rating, characteristically momeritical. Centains wedges of gypsum and anhydrite in lower part. About 525-557 ft thick.

Dip of bods: 35°-60° E.
Limestone (map unit, ls) about 100 ft above base and between two parts of unit. enerally good. Poor for most structures in lower part because of possible swelling of anhydrite, or settling because of leaching of Excavation: commonly
easy to depth of 6 ft
with most power betly fair. Foor to hazardous if bedding surfaces are undercut. Both debris may alide on Infiltration: slow Runoff: medium to Septic systems: generally unsatisfactory quality fill. hogbacks; maximum alopes range from 20° to 30°. (part) oderately susceptible to slaking. Where buried by rapid. with most power
equipment, moderately
difficult below 6 ft;
locally may require
blasting.
Compaction: moderately
difficult; hauling
equipment, posumatioand smooth-tire reliers
commenty used.
Drilling: moderately
difficult. Susceptibility to erosion: modera resistant where chiefly because
easily excavated
material generall
too thin for unficial deposits, uppermost zone of unit commonly altered and weakens to depth of 2-6 ft below base of surficial deposit. unventhered similar to "Pebbly sand, silt, and clay (SCP)" proper burial of system and risk moderate of pollution passing than 3 gpm. Encrusta-tions on well intakes through fractures supplies.
ump sites: peor
because excavat; may reduce yields in time. Quality: very hard; sulfate content high. (188: estimated poor source for domestic difficult. use; good source for stock use. Sandstone fine to very fine grained, moderately well sorted; moderately cemented at surface owing to weathering and casehardening, loosely cemented by clay where unweathered; very thin bedded to laminated alternately Sandstone Pierre Shale (part): Hygiene Sandstone Hember Oently rolling alluvium- and colluvium-In natural exposures, sandstone surface slightly case-hardened; moderately resistant to disinte-Permeability: low.
Water table: varies
greatly in depth.
Yield to wells: Excavation: moderately difficult with heavy to slow. Septic systems: varies, mostly unsatisfactory Mostly good. Poer to .basardous if bedding surfaces are undersut siltatone hunoff: medium.

usceptibility to

erosion: very slight
susceptibility to
mederately gray landes tractor-drawn rippers covered plains; slopes as steep as 25° along flames of messa east of mountain front. and scrapers.

Compaction: moderately

difficult; bauling because easily excavated very thin bedded to laminated alternately with siltstone; bedding even to way, persist ent laterally; composed of subangular to rounded quarts, mica, iron oxide, and some glauconite; organic material common. Siltstone well commonded by clay and delomite; clay minerals chieffy illite, sized-layer illite-mostmoffit@Mite less summant; Profitteding 0.3, Pohoritical; swell index, and part. Tetal bickness about 515-565 ft.

Dip of beds: 65% to vertical in merthern part of area; buff. 500 E. in southern part. reportedly as much as 12 gpm; more commonly resistant to disinte-gration; where buried by surficial deposits, surface of unit com-nealy altered to hard silty and elayey sand (SM, SCo) to depth of about 9 ft below base of surficial deposit. material commonly 2-5 gpm.
Quality: hard; iron
content commenly equipment, smooth-tire rollers commonly used. Drilling: mederately difficult. too thin for resistant. proper burial; percolation commonly satisfactory to excessive. Source for demestic use; good for stock marginal: where easily excavated material locally thick, suitability probably satisfactory. chiefly because excavation moderately difficult. Bandstone (71 percent), siltstone (17 percent), and claystone (12 percent). Sandstone; fineto medium-grained porous, well sorted; composed of subrounded to rounded clear to yellowish-stained quarts; well cemented by silica and iron oxide; in upper part laminated and platy thick bedded and ripple marked; bedding moderately persistent laterally, in lower part mostly massive, cross stratified, thickest beds 6-9 ft, thickness of beds variable but moderately persistent laterally; light yellowish gray. Biltstone and claystone: well cemented, hard; fissile to thin bedded, persistent laterally; composed chiefly of kallinite, illite, and mixed-layer illite-montmorillonite, dark gray in upper part, varicolored in lower part; PVC2/ rating, 0.8-1.5, non-critical; swell index, 800-1,300 psf. About 295 ft thick at Bear Canyon; increases to about 350 ft near Plainview.

Dip of beds: generally 400-600 B. except near faults where beds may be nearly vertical.

Joints conspicuous, mostly parallel to bedding and jointed transverse to beds.

Fractures open at surface, close gradually with depth; spacing of joints increases as Samistone, siltstone South Platte Excavation: difficult, generally requires blasting. Fractured and moderately to loosely cemented beds can be excavated with heavy tractor-drawn infiltration; medium.
hunoff; medium to
rapid. Permeability: generally high near outcrops and Beptic systems: generally unsatisfactory Excellent where hasard of reckelides on dip alope absent. sandstone surface generally case-hardened; moderately aries. Hazardous if bedding Lytle Formation surfaces are undercut.
Loose blocks and rock debris
may slide on dip slopes.
Locally some danger of
rockfalls along flanks
of steep ridges and in
cute. Inspection for
loose rock above building
sites recommended. brick and tile, where fractured brick and tile, and of buff-colored landscape "mose" reck. Local source of fair-quality riprep. to highly resistant to disintegration; alltstone and clay-stone surface Susceptibility to srosion: resistant probably medium at depth. because easily excavated materi ater table: generally slightly above level of streams near beserde generally too thim for proper burial of system and risk rippers and scrapers fractured by desiccation and outcrop area. Pressure gradient slopes east from outcrop area; some wells east of outcrop area flow; most have artesian rise. Tield to wells: ompaction: moderately difficult; hauling moderate of pollution passing release of rock pressure; mederately resistant to slaking. equipment, smooth-tire rollers commonly used. Drilling: difficult. through fractures into water supplies. poor because excavation reportedly as much as 20 gpm near outcrop; as much as to gpm difficult, access difficult, and risk moderate of ground-water pellution in east of outcrop; omnonly 5-15 gpm. Quality: very hard.
Use: reportedly good
source for domestic, outcrop area public supply, stock, and certain industrial Fractures open at surface, close gradually with depth; spacing of joints increases as beds thickness decreases. Sandstone: very fine- to medium-grained, fairly well sorted, composed of subangular to rounded frosted quarts; well cemented by silica; cross-stratified, flaggy in part ripple marked; light reddish brown. Total thickness about 250 ft.

Dip of beds: 40°-50° E. Joints very communications. chiefly narallel to bedding: Lyons Sandston Excavation: difficult; requires blasting. Compaction: difficult; generally requires mixing with binder material before prominent ledges of western hog-back; flatirons along east facs Permeability: generally high near outcrops and Same as for highly resistant to westhering; locally disintegrated chiefly "Swelling claystone ource of good-quality building stone and riprop. where fractured; probably medium at Susceptibility to erosion: very by freezing and Dump sites; Some wing of water in resistant. Water table: generally slightly above level of streams near siltatene (cs-ms)." on points very conspicuous, chiefly parallel to bedding; mederately open at surface, generally close with depth. Maximum thickness of beds: 1-2 ft, commonly 1-3 in. thick ereesfractures to yield piles of "Sandstone compacting. Eauling equipment commonly rubble (Rss)." outcrop area. Pressu gradient slopes east Drilling: very stratified layers. from outcrop area; no flowing wells reported. Yield to wells: none reported in area; probably can yield moderate quantities to wells near outcrop. reportedly flows 100 Quality: moderately Use: estimated good source for domestic, public supply, stock, and certain industrial Conglomerate and sandstone (90 percent), and siltstone (10 percent): very fine-to coarse-grained, poorly sorted, composed of subangular to subrounded fragments of quartzite and granite and grains of quartz, feldspar, mica, and clay minerals (kaelimite and mixed-layer illite-montmerillonite more abundant than illite); well commend by silica, hematite, and clay; lesticularly bedded; reddish brown to maroon. Total thickness about 800-1,050 ft.

Dip of beds: generally 300-600 E. except near faults where beds dip 260 E. through vertical to \$50 W. Beds mostly massive, jointed parallel to bedding, irregularly fractured. Fractures open at surface, close with depth. Maximum thickness of conglomerate lenses as much as 60 ft; of siltstone, as much as 15 ft. Fountain Formation Conglamerate wer ridges and n many patural Excavation: difficult: Infiltration: slow. Permeability: generally low; probably medium where faulted and preminent ledges of western Septic systems: generally unsatisfactory siltatone requires blasting; possibly excavated smally good. Loose blocks and rock debris may slide on dip slepe if support exposures, same as above; where buried by surficial deposits eresion: resistant. bogback. locally with heavy tractor-drawn rippers fractured. Water table: slightly my surficial deposits, uppermost zone of unit commonly leached of cement and disintegrated to silty and clayey sand and gravel (SC, GC, SM, GR2/) to depth because easily excavated material commonly too thin and scrapers.
Compaction: difficult;
generally requires
crushing and mixing above level of streets in fractures of rocks fer proper burial of system, and mear outcrops. Yield to wells: percolation commonly too slow with binder material commonly yields from less than 1 to 5 gpm; before compaction.

Bauling equipment and
steel-wheeled reliers
commonly used.

Drilling: difficult. locally marginal; risk moderate of locally as much as 15 base of surficial gpm reported. Underlying weathered and fractured some in deposit. Unit over-lies altered and pollution passing through fractures fractured zone 40-80 ft thick in igneous into water igneous and metamorphic rocks (chiefly gt, bg) and metamorphic rocks (chiefly gt, poor because excavation probably can yield moderate quantities. bg). Weathering products lend zone and manganese cent difficult, access appearance similar to that of "Conglomerate and siltstone." generally difficult, and high. Use: estimated generally fair to risk moderate of ground-water pollution in poor source for domestic use; good source for stock use liobrara Formation imestone and dolomitic siltstone: finely to ow ledges and low (part): Fort Hays coarsely crystalline, densely indurated, very hard. Map unit includes two belts parallelcavation: difficult; Infiltration: slow. Runoff: medium to rapid. Permeability: medium to high along hogbacks along valley formed in "Red siltatone requires blasting.
Compaction: difficult;
generally requires
mixing with binder
material before
compaction; healing
equipment commonly
used. moderately resistant to mechanical' ptic systems: troellest. enerally good. Loose blocks may slide on dip slope if Linestone Number generally unsatisfactory ing mountain front and separated by many fractures. weathering; generally surface roughened and pitted by solution. other map units of different lithologies: erosion: resistant. (ms)" and about 1/2 mile east of widely in lateral because cover commonly too thin for proper burial of system (part) Glennom Limestone eastern belt, gray limestone; beds as much source of as & ft thick, smooth, even, persistent laterally; total thickness about 30 ft; western belt pale-red dolomitic siltatome, and approximately parallel to hegtacks. extent. Artesian rise locally in wells. field to wells: and risk high of laminated; bedding wavy to contorted, interlaminated with silty limestone, delomite and claystone; total thickness about 0 ft. Dip of beds: \$60-600 E. Joints mederately pollution passing source for limited quantities of probably as much as 25 gpm locally. Encrustation on well Drilling: very difficult. through fractures into water supplies. intakes may reduce yield in time. conspicuous, chiefly parallel to bedding. Joint patters blocky in eastern zone; irregular in chiefly 1/8- to 1-in. thick poor because excavation difficult and quality: hardness; unknown; sodium layers of rock in western some. bicarbonate content probably high. se: estimated good risk high of ground-water pollution in fair source for outcrop area. domestic, public supply, stock, and certain industrial

1/For detailed discussion of stratigraphy of these ammonite zones see Scott and Cobban (1965).
2/Potential Volume Change. For discussion see explanatory notes to this report and Lambe (1960).
3/Unified Soil Classification (U.S. Army Corps Engineers, 1953).

THIS REPORT IS PRELIMINARY AND HAS NOT BEEN EDITED FOR COMPORMITY WITH U.S. GEOLOGICAL SURVEY STANDARDS AND HOMESCLATURE.